(prepared by Miss M. Welch), especially since most of the articles are in readily accessible journals.

The weather factor in the great war. [Title varies.] (Popular sci. monthly, N. Y. v. 85. Dec. 1914. p. 604–613; Journal of geography, Madison, Wis. V. 13. Feb., Mar., June, 1915. p. 169–171; 209–216; 315–317. V. 14. Nov., 1915; June, 1916. p. 71–76; 373–384. V. 15. Nov., 1916; Apr., 1917. p. 79–86; 245–251. V. 16. Oct., Nov., 1917; Apr. 1918. p. 47–51; 86–90; 291–300.)

Weather and the war. (Journal of the military service institution, Governor's Island, N. Y. v. 61. July–Aug. 1917, p. 43–50; Sept.–Oct. 1917, p. 145–155; Nov.–Dec. 1917, p. 293–302.)

Weather controls over the fighting in the Italian war zone. (Sci. monthly, N. Y. v. 6, Feb., 1918. p. 97–105.)

Weather controls over the fighting in Mesopotamia, in Palestine, and near the Suez Canal. (Sci. monthly, N. Y. v. 6, Apr., 1918. p. 289–304.)

Weather controls over the fighting during the spring of 1918. (Sci. monthly, N. Y. v. 7. July, 1918. p. 24–33.)

Weather controls over the fighting during the summer of 1918. (Sci. monthly, N. Y. v. 7. Oct. 1918. p. 289–298.)

Weather controls over the fighting during the autumn of 1918. (Sci. monthly, N. Y. v. 8. Jan., 1919. p. 1–15.)

In *The Windsor Magazine* (London), a British author, E. D. Ushaw, has published on the same subject from somewhat different sources. See extensive quotation in *The Literary Digest* (New York), Mar. 29, 1919, pp. 88, 91 and 94.—C. F. B.

MEASUREMENTS OF THE SOLAR CONSTANT OF RADIATION.

By C. G. ABBOT,

Assistant Secretary of the Smithsonian Institution.

By invitation of Prof. Marvin, Chief of the United States Weather Bureau, the Smithsonian Institution will communicate from time to time, as received, the measurements of the solar constant of radiation which are being made by its observers at Calama, Chile. The present paper gives in Table 1 the values which have been received hitherto from the station, beginning with July 27, 1918.

The values are being communicated daily by telegraph from Calama to Buenos Aires and by letter to Rio de Janeiro, as the meteorological services of Argentina and Brazil are conducting a test of their value for purposes of forecasting. The usefulness of the solar constant results for this purpose is not so firmly established as to warrant the expense of telegraphing the results to the United States, but in order to put them as speedily as feasible before meteorologists, Prof. Marvin has thought good to arrange for their regular publication in the MONTHLY WEATHER REVIEW.

It is to be understood by the reader that these values are preliminary, and subject later to detailed revision and occasional change as they will be published in extenso by the Smithsonian Institution; but the changes which will be made in such revision will probably be small, and oftentimes no change at all will occur.

The solar constant of radiation as here defined is the intensity of the solar radiation as it would be outside of the earth's atmosphere at mean solar distance. It is determined by the use of the spectro-bolometer and pyrheliometer in the manner described by the writer in the MONTHLY WEATHER REVIEW for January 1919 (vol. 46, pp. 1–3), where an account of the South American Expedition of the Smithsonian Institution is given.

In the following publications we shall give values of the solar constant in calories per square centimeter per minute, values of the atmospheric transmission coefficient at wave length 0.50 microns, indications of the trustworthiness of the results, indications of the humidity of the air prevailing at the earth's surface and also as integrated through the whole path of the earth's atmosphere between the observer and the sun, and, finally, notes as may be desirable, explanatory of the results of individual days.

In estimating the trustworthiness of the individual values, the following criteria are employed: First, as to the internal evidence of the goodness of the observations. This depends upon the mutual support offered by the six bolographic observations of a given day. If the transparency of the atmosphere remains unchanged during the several hours required to determine it, the logarithms of intensities at each of the several wave lengths where measurements are made in the solar spectrum should be proportional to the air mass traversed by the solar beam in the atmosphere. In other words, the logarithmic plot whose ordinates are logarithms of intensity and whose abscissæ are air masses (or roughly secants of the sun's zenith distance) should approach a straight line for each individual wave length in the spectrum. Noting the proportion of 40 different wave lengths for which this criterion is well supported on a given day, the observers draw their conclusion as to whether the constancy of the transparency for the day was excellent, very good, good, or poor, and they indicate this judgment by the letters E, VG, G, and P. Sometimes they further qualify these characters by the symbols + and −. Thus E− indicates a day on which the logarithmic plots were generally very straight, but not quite as satisfactory as for a day marked E. When the mark given is E+, it indicates that no improvement on the merit of the day from the point of view of the logarithmic plots could reasonably be hoped for. Days marked G−, or P are entitled to little weight unless the defect of the observations should be explainable by reason of earthquakes or magnetic storms which, while they might introduce irregularities in the spectro-bolographic determinations, would yet be independent of variations of the transparency of the air.

It is a weakness of the method that the determinations of the atmospheric transmission require several hours of unchanged transparency of the air. We are developing an empirical method, based upon the full spectro-bolometric method, by means of which we hope to shorten the period required to determine the solar constant to a few minutes, and it is possible that the application of this new method may enable us to materially improve the results.

Further conclusions as to the merits of individual determinations are based upon visual examination of the sky during the period of observation. If cirrus clouds are seen in the same quarter of the sky as the sun, and especially if they spring up during the observations, or pass off during the observations, this fact tends to weaken the day's result. Also, if there has been during the days immediately preceding, or if there follows in the immediately succeeding days, a period of cloudiness, this weakens the result. Special considerations of this character should be taken into account in the estimation of the merit of the day. It is regretted that the sky has

not proved as free from clouds at Calama as available meteorological observations led us to expect before we established the solar station there.

Further considerations are based upon the degree of humidity prevailing and on the substantial constancy or variability of it during the observations. Three columns are devoted to humidity. The first, designated by ρ/ρ_{sc} indicates the relative intensity in the middle of the water vapor band called by Langley. ρ, σ, τ, as compared with the intensity indicated by the smooth curve over the top of the band, or in other words as it would be observed by the bolometer if the humidity were zero. This ratio for ρ/ρ_{sc} gives thus an index of the integrated humidity prevailing between the observer and the outside limit of the atmosphere in the direction of the sun.

The second and third columns of humidity give the observed vapor pressure and relative humidity prevailing at the station as measured by the Assmann ventilated psychrometer. All humidity values given relate to the air mass where secant z equals 3.0.

TABLE 1.—*Solar constant, atmospheric transmission, and atmospheric moisture values, measured at Calama, Chile, July, 1918, to January, 1919, inclusive.*

Date, A. M. or P. M.	Solar constant.	Grade.	Transmission coefficient at 0.5 micron.	Humidity (Air mass=3.) ρ/ρ_{sc}	V. P. cm.	Rel. hum. %.	Remarks.
July 27, A. M..	1.944	VG...	0.862	0.655	0.10	14	
28, A. M..	1.901	VG+.	.852	.587	.14	20	
29, A. M..	1.809	VG...	.857	.590	.15	22	
30, A. M..	1.920	VG—.	.835	.595	.15	22	
31, A. M..	1.932	VG+.	.859	.538	.16	23	Cirri in south and west.
Aug. 1, A. M..	1.945	VG+.	.875	.627	.11	18	
3, A. M..	1.966	E—...	.868	.672	.09	16	Some cirri.
4, A. M..	1.948	VG...	.845	.673	.08	14	
5, A. M..	1.954	E—...	.865	.705	.06	11	
6, A. M..	1.972	E—...	.862	.675	.06	11	
7, A. M..	1.948	E.....	.870	.652	.10	16	
8, A. M..	1.955	VG+.	.882	.677	.10	13	
10, A. M..	1.954	E—...	.866	.619	.13	19	
11, A. M..	1.965	VG—.	.868	.656	.09	13	
12, A. M..	1.959	E.....	.866	.745	.08	11	
14, P. M..	1.925	VG+.	.858	.559	.22	15	
15, A. M..	1.947	VG...	.855	.595	.15	23	
16, A. M..	1.987	VG+.	.853	.705	.07	11	
17, A. M..	1.888	VG+.	.874	.552	.08	15	Scattered cirri and cumuli at 11 a. m. Almost entirely overcast by 2 p. m.
19, A. M..	1.948	E—...	.871	.457	.22	26	Low cumuli in east. Small floating clouds high in south.
20, A. M..	1.940	E—...	.860	.574	.21	26	
21, A. M..	1.995	VG+.	.866	.814	.07	9	
22, A. M..	1.953	E.....	.858	.726	.06	10	
23, A. M..	1.979	E+...	.859	.739	.08	12	
24, A. M..	1.932	G.....	.850	.705	.09	16	
25, A. M..	1.968	E—...	.856	.693	.07	12	
26, A. M..	1.949	VG+.	.865	.647	.09	12	
27, A. M..	1.955	E.....	.865	.677	.11	13	
28, A. M..	1.894	E—...	.862	.599	.12	16	
29, A. M..	1.954	VG+.	.832	.523	.14	19	
30, A. M..	1.953	VG+.	.828	.474	.20	29	
31, P. M..	2.018	G+...	.817	.444	.37	21	Considerable cumulus in north and east. Cirri near sun latter part of observation.
Sept. 1, A. M..	1.980	VG—.	.855	.468	.23	27	
6, A. M..	1.937	VG+.	.845	.381	.38	61	Bank of cumulus in east, also in northwest.
7, A. M..	1.951	E—...	.860	.542	.18	24	
8, A. M..	1.911	E.....	.862	.705	.09	15	
9, A. M..	1.931	VG—.	.866	.638	.07	11	
14, A. M..	1.931	VG+.	.866	.531	.29	41	Patches of cirrus not far from sun.
15, A. M..	1.935	VG—.	.863	.621	.15	27	
16, A. M..	1.960	E.....	.845	.747	.06	10	
17, A. M..	1.951	VG+.	.861	.764	.05	8	
18, A. M..	1.958	VG...	.851	.691	.09	15	
19, A. M..	1.943	E.....	.863	.728	.10	15	
21, P. M..	1.937	E.....	.858	.423	.30	14	Considerable cirrus in west and east.
22, A. M..	1.938	E.....	.851	.406	.19	25	Considerable cirrus.
26, A. M..	1.950	E—...	.856	.697	.08	12	Cirri low in north and east.
27, A. M..	1.924	E—...	.854	.667	.13	20	
28, A. M..	1.949	E.....	.833	.761	.12	19	
29, A. M..	1.978	VG+.	.848	.683	.08	13	
30, A. M..	1.936	VG+.	.835	.738	.07	6	Cirri in east.

Date, A. M. or P. M.	Solar constant.	Grade.	Transmission coefficient at 0.5 micron.	Humidity (Air mass=3.) ρ/ρ_{sc}	V. P. cm.	Rel. hum. %.	Remarks.
Oct. 1, A. M..	1.932	VG+.	.849	.716	.08	13	Low cirrus in south.
2, A. M..	1.932	E—...	.850	.668	.10	16	
3, A. M..	1.936	E.....	.855	.740	.07	11	
4, A. M..	1.942	E.....	.848	.745	.06	10	
5, A. M..	1.963	VG...	.853	.712	.06	9	
6, A. M..	1.980	E—...	.855	.699	.08	12	
7, A. M..	1.929	E—...	.855	.725	.07	12	
8, A. M..	1.945	E.....	.850	.677	.08	13	
9, A. M..	1.941	E—...	.851	.712	.06	12	
10, A. M..	1.950	VG+.	.862	.676	.07	8	Cirri all around sky.
11, A. M..	1.865	VG...	.858	.558	.08	11	Cloudiness in east. Scattered cirri in north, south, and low in west.
13, P. M..	1.951	VG...	.855	.461	.29	13	
14, P. M..	1.946	G+...	.865	.478	.35	15	Cumuli in east. Line of small cirro-cumuli in southwest.
15, A. M..	1.957	G—...	.855	.445	.18	24	Bank of cirrus in northeast.
16, A. M..	1.941	G—...	.850	.463	.20	41	
17, A. M..	1.935	VG...	.853	.455	.23	31	Considerable cirrus in northeast.
18, A. M..	1.939	VG....	.848	.713	.09	11	
19, A. M..	1.908	VG+.	.863	.627	.13	15	Cirri in north.
21, A. M..	1.958	VG+.	.860	.544	.18	24	Cirri in northeast.
25, P. M..	1.882	VG—.	.855	.418	.38	19	Scattered cirri.
28, A. M..	1.903	VG+.	.861	.488	.23	33	Cirri in north and east.
29, A. M..	1.928	VG...	.852	.525	.17	27	
30, A. M..	1.927	G.....	.858	.542	.17	29	
31, A. M..	1.901	VG...	.840	.485	.21	33	Cirri in northeast.
Nov. 1, A. M..	1.876	VG...	.871	.645	.15	22	Cirri low in northeast.
5, P. M..	1.921	VG—.	.855	.500	.22	10	Cirri in east.
6, A. M..	1.893	G.....	.864	.548	.17	24	Low cirri in west.
7, A. M..	1.956	VG+.	.862	.622	.14	18	Cirri in east.
8, A. M..	1.969	VG+.	.845	.613	.15	18	
9, A. M..	1.951	VG—.	.847	.512	.16	23	Scattered cirri.
12, P. M..	1.954	E—...	.855	.641	.24	11	Cirrus in north and east, with two patches below sun in west.
13, A. M..	1.941	G+...	.850	.575	.19	22	Some cirri in east.
15, P. M..	1.969	VG—.	.829	.454	.32	15	Cirri in east, but disappearing.
16, A. M..	1.924	VG...	.848	.483	.23	30	Some cirri in northeast.
17, A. M..	1.934	E.....	.845	.507	.21	28	Low bank of cirrus in northeast.
18, A. M..	1.945	E—...	.854	.469	.31	31	Thick bank of cirrus in east below sun.
19, A. M..	1.931	VG...	.839	.400	.28	31	
20, A. M..	1.963	E—...	.801	.348	.36	47	Cirri in north and east More forming continually.
21, P. M..	1.945	VG—.	.831	.446	.33	16	
22, P. M..	1.962	E—...	.840	.467	.31	15	Cirrus in north.
23, P. M..	1.972	VG—.	.827	.464	.34	17	Cirri in north and east—increasing.
25, A. M..	1.990	E—...	.822	.351	.43	56	Cirri in north, southwest, and low in east.
26, A. M..	1.924	VG—.	.829	.330	.28	36	Cirro-cumuli in east and west.
27, P. M..	1.925	VG...	.848	.506	.24	13	Cumuli in east and south.
28, P. M..	1.917	G+...	.848	.502	.28	12	Floating clouds in southwest and in east.
29, P. M..	1.962	VG...	.848	.543	.26	13	Few cumuli in east.
30, A. M..	1.926	VG...	.862	.511	.18	23	
Dec. 1, A. M..	1.964	E—...	.853	.539	.21	24	Few patches of cirrus in north.
2, A. M..	1.954	E.....	.853	.546	.21	26	
3, A. M..	1.967	E.....	.874	.590	.17	22	
4, A. M..	1.999	VG...	.854	.687	.10	13	Cirrus disappearing in northeast.
5, P. M..	1.986	G—...	.833	.591	.28	14	Scattered cirri.
6, P. M..	1.954	P+...	.827	.447	.32	15	
7, A. M..	1.983	E—...	.832	.461	.26	24	
8, A. M..	1.925	E—...	.828	.333	.34	34	Thin floating clouds in south, southeast, and southwest.
9, P. M..	1.939	VG+.	.832	.392	.35	15	Floating clouds low in east.
10, A. M..	1.947	E.....	.844	.453	.28	25	
11, A. M..	1.943	E.....	.855	.532	.19	20	Few patches of cirrus in northwest.
12, A. M..	1.951	VG+.	.852	.551	.17	17	Cirri moving rapidly from northwest.
13, P. M..	2.013	VG+.	.830	.491	.27	11	Cirri scattered over sky with large bank in west.
22, A. M..	1.925	VG+.	.842	.359	.52	51	Cirrus in east and northeast, disappearing.
23, A. M..	1.984	E—...	.851	.433	.37	42	
26, A. M..	1.952	E—...	.834	.397	.31	30	
27, A. M..	1.950	E—...	.852	.532	.25	30	Small patch of cirrus in north.
28, A. M..	1.948	E—...	.857	.522	.19	23	Cirrus scattered over large part of sky.
31, A. M..	1.942	E.....	.858	.429	.35	41	
1919.							
Jan. 1, A. M..	1.960	E—...	.854	.433	.21	28	
2, A. M..	1.969	E—...	.853	.446	.23	27	Bank of cirrus in northeast.
3, A. M..	1.974	E—...	.848	.428	.30	36	Bank of cirrus in northeast.

TABLE 1.—*Solar constant, atmospheric transmission, and atmospheric moisture values, measured at Calama, Chile, July, 1918, to January, 1919, inclusive*—Continued.

Date, A. M. or P. M.	Solar constant.	Grade.	Transmission coefficient at 0.5 micron.	Humidity (Air mass=3).			Remarks.
				p/p_{so}	V. P. cm.	Rel. hum. %.	
Jan. 6. A. M...	1.890	VG+.	.840	.270	.48	45	
8. A. M...	1.899	VG+.	.845	.336	.39	39	Cirri all around horizon.
11. A. M...	1.941	E—...	.855	.425	.41	43	
12. A. M...	1.888	E.....	.870	.568	.38	38	Some cirri in east and north
14. A. M...	1.963	VG—.	.868	.637	.26	32	Considerable cirrus in east and south.
16. A. M...	1.948	E—...	.841	.371	.45	50	Considerable cirrus in east and north, with large patches in west.
17. P. M...	1.930	VG—.	.851	.423	.39	16	Considerable cirrus in east, but disappearing.

TABLE 1.—*Solar constant, atmospheric transmission, and atmospheric moisture values, measured at Calama, Chile, July, 1918, to January, 1919, inclusive*—Continued.

Date, A. M. or P. M.	Solar constant.	Grade.	Transmission coefficient at 0.5 micron.	Humidity (Air mass=3).			Remarks.
				p/p_{so}	V. P. cm.	Rel. hum. %.	
Jan. 18. A. M...	1.978	VG—	..858	.495	.31	32	Streaks of cirrus low in west.
19. A. M...	1.952	E—...	.873	.630	.23	28	
20. A. M...	1.960	VG+.	.874	.445	.48	51	
21. A. M...	1.932	VG+.	.854	.430	.39	42	
22. A. M...	1.939	E—...	.852	.384	.38	40	Thin cirri on north and cumuli at horizon in east.
23. A. M...	1.930	E—...	.847	.344	.39	38	Patch of cirrus in southeast
24. A. M...	1.906	E—...	.836	.305	.40	48	
25. A. M...	1.969	VG+.	.822	.311	.58	61	Cirrus low in west.
26. A. M...	1.926	E—...	.857	.387	.51	51	Small patch of cirrus near horizon in east.

THE DIRECTION OF ROTATION OF CYCLONIC DEPRESSIONS.

By J. S. DINES, Meteorological Office, London.

[Dated: Jan. 16, 1919.]

In a recent number of Nature (Dec. 12, 1918) I called attention to the fact that there is no dynamical reason why cyclonic circulation should not take place in the opposite direction to that commonly experienced. That is, clockwise circulation round a low pressure center may theoretically occur in the Northern Hemisphere and counter clockwise in the Southern. This result is apparent on consideration of the gradient wind equation connecting the velocity V with the pressure gradient γ.

The equation is

$$\frac{\gamma}{D} = 2\omega. V. \sin \lambda + V^2. \cot \rho / R$$

where D is density, ω angular velocity of the earth, λ latitude, R radius of the earth and ρ angular radius of curvature of the air path.

This equation being a quadratic in V has two roots, a positive one which corresponds with the normal circulation and a numerically larger one of negative sign corresponding with reversed circulation. Both these roots represent a stable state and therefore the only reason which appears to exist to prevent the reversed cyclone is that it can not get started, the rotation of the earth inevitably causing counter clockwise rotation to be set up in the Northern Hemisphere immediately any low pressure center is formed.

In a circular cyclone of the reversed type if the pressure gradient remain constant with increasing distance from the center the wind velocity will become very great in the outer regions, where ρ is large. It seems to follow that in such a cyclone the pressure gradient must fall off rapidly from the center and the steep gradient often found over large areas in normal cyclones could not occur in the reversed type.

In the case of circulation round a high pressure center the positive sign in the above equation is replaced by a minus sign. Two roots for V again appear, but in this case both are of the same sign and therefore both correspond with clockwise rotation in the Northern Hemisphere.

It seems possible that the reversed cyclone may be formed on a small scale by accidental causes such as an eddy set up round a precipitous headland, and perhaps under favorable conditions such a whirl might develop into a tornado, retaining its clockwise rotation. Little attention seems to have been devoted to the direction of rotation of tornados and evidence on the point is sometimes conflicting. Thus in the MONTHLY WEATHER REVIEW for April, 1918, a whirlwind at Pasadena, Calif., was described and Prof. E. Ellerman, of Mount Wilson Solar Observatory, recorded his impression that the rotation was clockwise.

The author of the paper apparently did not consider this evidence conclusive and the question remains open. One would like to impress strongly on observers of such phenomena the importance of taking careful note of the direction of rotation. A study of the damage along the storm track should afford conclusive evidence in the majority of cases. In this respect observers in the United States are in a much more favorable position than those in this country, owing to the extreme rarity of such phenomena in Europe.

An interesting fact which emerges from a study of the roots of the equation is that whereas in the case of a large depression the velocity in the reversed cyclone is decidedly greater than in the normal type for any given gradient, in small whirls of the tornado type it is almost the same in either direction. There is thus no reason to think that with a given decrease of barometric pressure at the center the reversed tornado would be appreciably more or less destructive than the counterclockwise type.

It has probably been generally recognized that a small whirl can rotate in either direction, but the fact that the same principle applies to a large cyclonic depression appears to have escaped attention.

DISCUSSION.

While the main point of Mr. Dines's paper is the proof of the dynamic possibility and a call for observations of reverse cyclones, the results of a further discussion of this matter in the Central Office of the Weather Bureau may be of interest.

A "gradient wind," by definition, flows in a direction perpendicular to the gradient and at such a velocity that two of the three forces, (1) gradient, (2) deflective effect of the earth's rotation, and (3) centrifugal force, acting